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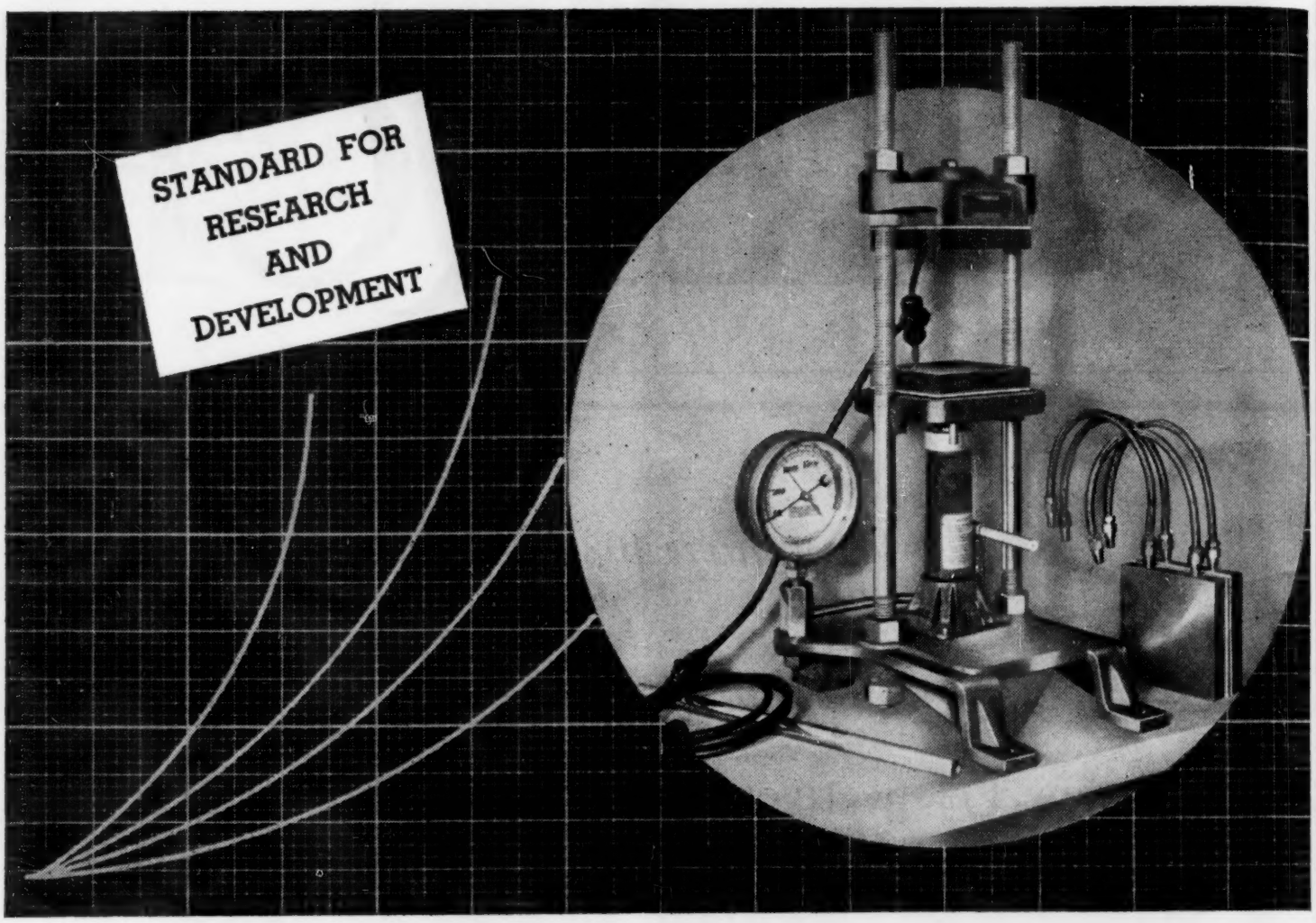

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SCIENCE

Vol. 104 No. 2688 Friday, 5 July 1946

New Perspectives in Forest Tree Breeding

F. I. Righter

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IT IS GENERALLY ASSUMED that agricultural plant-breeding concepts and procedures must be adopted in breeding forest trees. These concepts and procedures are, of course, adapted to the materials and conditions of agriculture, which, in numerous respects, are fundamentally different from those of silviculture. As they are incapable of quickly producing practical benefits from tree-breeding work, the assumption has given rise to much skepticism regarding the practicability of breeding forest trees, and it has also delayed progress in tree breeding by causing resources to be expended on inefficient methods. In applying genetic principles to the improvement of silviculture, it is essential at the outset to recognize that the most effective procedure will be that which is best adapted to the materials and conditions of silviculture. Therefore, if proper perspective is to be gained, the problem of breeding forest trees must be viewed against a silvicultural background. Such perspective gives rise to new concepts which suggest a unique procedure capable of producing practical benefits very quickly. The concepts and the essentials of the procedure derived from them are briefly presented herewith.

In agriculture a high degree of genetic uniformity is deemed to be essential in the original stand of a crop. The general assumption that this basic premise is also axiomatic in silviculture leads to the following conclusions: (1) performance testing cannot be combined with crop production but must be conducted as a separate breeding operation; (2) if propagation is to be by seed, true breeding forms are required as parents; hence, (3) the progeny of a hybrid cannot be used; and therefore, (4) an area stocked with a hybrid must be replanted upon harvesting the hybrid.

These conclusions are logical, but the basic premise is not valid because the eventual loss of 90 per cent or more of an original stand, which would be ruinous in agriculture, is natural and beneficial in silviculture, which depends on close spacing to insure good stem form and on the gradual elimination of most of the stand through competition to accommodate growth in size. Thus, it is evident that genetic uniformity is not required in silviculture; in fact, it is seldom, if ever, encountered. Moreover, because of the impracticability of protecting forests from diseases and insects, it would be extremely hazardous in silviculture.

The fact that genetic uniformity is not required greatly simplifies and shortens tree-breeding procedure. For example, if increased rate of growth is the objective, performance testing can be safely combined with crop production by interplanting a promising new or selected population with the commonly used stock. In such a planting, the former will occupy every second or third or fourth, etc., row, depending on spacing and other considerations. Then, if it is adapted to the site and decisively superior to its competitor in rate of growth, it will gradually suppress and eliminate the latter, as well as some of its own weaker or less favored members, and it will occupy the site at maturity. In such an event, practical benefits will begin to accrue as soon as the stock is planted. If, however, the common stock is superior, it will occupy the site at maturity and nothing will be lost through failure of the new form. Finally, if the two forms are equal in vigor and adaptability, the final stand will consist of both, and the yield will be unaffected. Regardless of the outcome, a test will have been made without loss in productivity of the land. This method of testing also (1) provides a convenient means of testing materials on a large scale under forest conditions and (2) makes the most economical use of a superior stock, since fewer of its members will be sacrificed to accomplish the purposes of close spacing than would be the case if they were planted en masse.

The interplanting method of testing performance makes it possible to obtain practical benefits quickly from tree breeding provided superior trees can be produced rapidly in large quantities. Superior trees can be produced through selection or hybridization;

[1] Maintained by the Forest Service in cooperation with the University of California.

but heretofore selection has generally been regarded as the more promising method. Large-scale production of hybrids through controlled pollination has been suggested by several authors, but the general opinion regarding its difficulties, which is based largely on experience with angiosperms, has not justified optimism, and consequently the impracticability of the method has been tacitly or expressly assumed. This assumption is not necessarily valid, inasmuch as many of the most important timber-tree species are gymnosperms. Between the angiosperms and the gymnosperms there are fundamental differences in factors that affect crossability and fertility and hence the ease with which hybrids and their progenies can be produced in abundance. For example, double fertilization, which in effect may be a barrier to crossability (D. C. Cooper and R. A. Brink. *Science,* 1942, **95**, 75), is not encountered in the conifers. Moreover, chromosome mutation, which has been a prominent causative factor in the evolution of the angiosperms, appears to have been relatively unimportant in the evolution of the conifers, inasmuch as cytological investigations have shown that there is little or no variation among coniferous species in number, morphology, and behavior of their chromosomes (K. and H. J. Sax. *J. Arnold Arboretum,* 1933, **14**, 356). Hence, speciation in coniferous genera may be attributed mostly to gene mutation. From this it has been suggested that many species of a genus may not differ enough to prevent interspecific hybridization and relatively high fertility in the hybrids. In short, crossability among the angiosperms may be limited by genic and genomic differences between species, as well as by double fertilization, whereas among the conifers it may be limited for the most part mainly by genic differences between species.

Some years ago, in considering these and other differences between gymnosperms and angiosperms, it occurred to me that many fertile, coniferous hybrids could be produced readily and in large quantities through controlled pollination. This hypothesis had some support in the occurrence of natural hybrids, several of which were known to be fertile, whereas none were known to be sterile. Tests conducted at the Institute of Forest Genetics, Placerville, California, have since shown that the hypothesis is entirely tenable. For example, the number of sound seed obtainable per 1,000 pollination bags,[2] as judged by results of smaller tests, from 16 interspecific crosses in *Pinus* ranged from 5,100 to 238,500. From each of 10 of the crosses sufficient sound seed was obtained per 1,000 bags to produce enough seedlings (after deducting 40 per cent for failure to germinate, mortality, culling, etc.) to stock more than 100 acres when interplanted to every sixth row, or at the rate of 200 seedlings per acre in a spacing 6 feet by 6 feet. Progenies of several of these hybrids are already under observation in the nursery. These results are only indicative of the possibilities. Most of the crosses were made between single individuals of the parental species. Increased yields may be expected from including in a cross numerous individuals of the parental species and from improving techniques. Lower costs may be expected to result from economies incidental to large-scale operations.

The foregoing considerations, together with others to be presented later, indicate that certainly among the conifers, and possibly among the angiospermous trees as well, numerous interspecific hybrids can be produced in large quantities at reasonable cost through controlled pollinations. Both genetic theory and experimental results indicate that many of the hybrids will have a much greater rate of growth than one or the other of the parental species and that some of them will be more vigorous than both parents. They can therefore be used to increase timber production within the distribution range of the weaker, if not of both, parental species. The interplanting method of testing performance makes it possible to take advantage of their potentialities immediately and at a lower cost than if it were necessary to plant pure stands of improved varieties.

We are now in a position to consider breeding procedure. Since genetic uniformity is not required in silviculture, hybridization on a large scale, followed by the production of an enormous F_2 population from natural interbreeding among the hybrids, recommends itself as a highly practicable and effective procedure. Its essentials are as follows: Two species are crossed on a small scale to ascertain crossability. If hybrids are obtained, their vigor and form are tested by pitting them against the parental species in small nursery tests for two or three years. If the hybrids prove to be readily obtainable and of sufficient promise, they are then produced in quantity and interplanted with the common stock on the area to be reforested.

Assuming that the hybrid population proves to be adapted to the site, superior to its competitor in rate of growth, and satisfactory in other respects, the next step is to decide what to do about the succeeding crop. This will depend upon the hybrid's fertility, the growth rate of the more vigorous members of its progeny, and the ability of the latter to establish itself naturally. These questions can be resolved considerably in advance of harvesting by means of investigations of seed production and of ability of the F_2 generation to establish itself and by testing the vigor

[2] The seed-production phase of a thousand-bag breeding job on large trees requires from 30 to 45 man-days, depending on travel required and other circumstances.

of the latter in small experiments in the nursery and in plantations. If the results of such investigations are favorable, restocking of the area is left to the F_2 population. This population, which will exhibit great genetic diversity, will then be subjected to natural selection and, better still, resources permitting, to artificial selection also, since the great flexibility of silvicultural art makes such selection readily applicable. If the results are unfavorable, the area is replanted with the F_1 hybrid or, perhaps, a backcross of one of the parental species and the hybrid.

The concepts and derivative procedure presented herein, together with breeding results obtained in recent years at the Institute of Forest Genetics, provide a reasonable basis for stating that forest tree breeding can yield substantial practical benefits even more quickly, perhaps, than they are ordinarily obtained from breeding agricultural plants.

Technical Papers

The Property of Certain Calcium Silicates to Impart Supersaturation of $CaCO_3$ to Carbonatated Water Extractions

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The presently noted property of calcium silicates was observed in recent experiments that were prompted by certain carbonate *versus* silicate studies conducted at the Tennessee Agricultural Experiment Station in 1914–1916 (*4, 7, 8*). Although the efficacy of silicates of calcium as liming materials then was deemed primarily of academic interest, the utilization of such silicates in soil liming became a matter of practical importance when phosphate-reduction furnace operations brought substantial tonnages of slag that carries calcium silicate in the range of 80 to 85 per cent of $CaCO_3$-equivalence. When air-cooled, this slag is visibly crystalline; when quenched, it is a "glassy" material. When incorporated as the "unground" granulated by-product, and also as −20 + 60-mesh siftings, in the rate range between 2 and 40 tons per acre, the quenched slag proved highly beneficial to plant growth. But, when incorporated as −100-mesh screenings at rates beyond 5 tons per acre, the initial infertility resultant from the heavy incorporations of the 100-mesh quenched slag was succeeded ultimately by marked fertility, the rapidity of recovery being inverse to the increase in the rate of incorporation. In contradistinction, the mineral silicate, wollastonite, proved effective upon both the immediate and the subsequent plant growth, regardless of the fineness and the rate of the incorporations. Although the larger fraction of the detrimental input of slag-calcium had been converted from silicate to carbonate during the growth of the initial crop, the repressive effect upon plant-growth was protracted. The transition of the heavily slagged soils from a state of virtual sterility to one of fertility was retarded by the periodically determined high alkalinity that prevailed during the persistence of the calcium silicate of the incorporated glassy slag. Progression in the carbonatation of incorporations of quenched slag in parallel with wollastonite and with limestone, all being −100-mesh, therefore was determined by subjecting the treated soils to a succession of analyses to determine $CaCO_3$ content. These analyses established the surprising fact that 40-ton, $CaCO_3$-equivalent incorporations of wollastonite remained uncarbonatated in the soil, upon which 9 crops had been grown in succession, although the corresponding incorporations of slag showed $CaCO_3$ cumulations of 30 tons per acre.

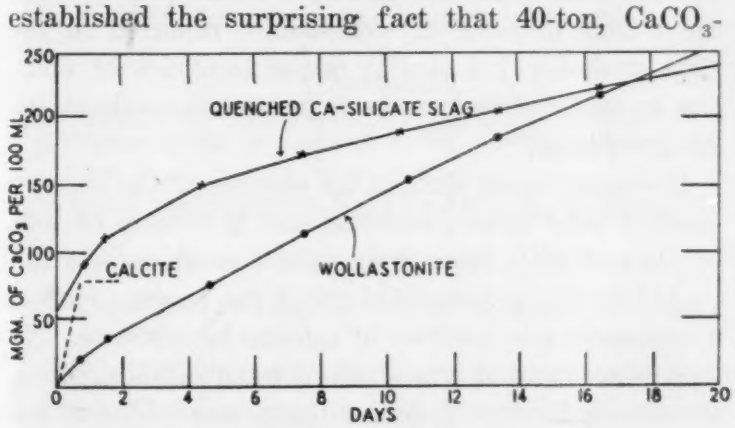

FIG. 1. Formation of calcium bicarbonate through progressive dissolution of certain silicates in carbonatated water (1 atmosphere of CO_2 at 30° C.).

Since this protracted resistance of the wollastonite against carbonatation in the several soil systems was opposite to the expectancy pointed by the preceding studies of carbonatated water suspensions of carbonates and silicates (*4–9*), the presently reported carbonatated water digestions of wollastonite, slag, and calcite (and also limestone and precipitated $CaCO_3$) were made in an attempt to clarify the apparent anomaly. The results graphed in Fig. 1

were obtained from the respective suspensions of 5 grams per 1,200 ml. of carbonatated water, under pressure of one atmosphere of CO_2 at 30° C. for 20 days. The suspensions were contained in 2¼-liter reagent bottles that were placed in an upright position on the horizontal plane of a reciprocating shaking machine. The several systems were purged by a current of CO_2, an atmosphere of which was maintained above the continuously agitated solution suspensions through connection with a gas reservoir provided with a waterhead of 12 to 18 inches. At the several successive periods, 100-ml. aliquots of the carbonatated water extracts were filtered and titrated with N/10 HCl against methyl orange; CO_2 pressure was restored in the systems and agitation continued.

The graphed results of the successive titers show that (a) the concentrations of the solutions of calcium bicarbonate derived from wollastonite and quenched slag quickly progressed beyond those derived from the calcite in its equilibrated system, and (b) the dissolution of the glassy slag was more rapid than that of the crystalline wollastonite. The larger titers of the carbonatated water extracts of the two silicate materials were found attributable almost entirely to calcium bicarbonate, the final incidence of SiO_2 in those extracts being only 1/18 of the titrated $CaCO_3$-equivalence. Since this had been found true also for the 4-hour extracts of wollastonite reported in the 1914 studies (*7*) a similar minor incidence of silica can be assumed to have been present throughout the 20-day period.

It was apparent that, in the absence of $CaCO_3$ as a starting solid phase, concomitance in release of ions of Ca and SiO_2 from their silicate combinations imparted to the carbonatated water the power to effect a supersaturated solution of calcium bicarbonate. No such concentration was attained when colloidal silica, as such or through sodium silicate, was added to the carbonatated water either before or after any form of calcium carbonate was subjected to extractions therewith. A similar disparity obtained when the ultimate concentrations of carbonate in the carbonatated water extractions from the silicate materials were compared with those derived from $Ca(OH)_2$ as the starting solid, along with additions of silica as the hydrosol or as sodium silicate. Moreover, when pulverized quenched slag was subjected to a succession of digestions to virtual equilibrium in carbonatated water and then used as the starting solid for carbonatated water extractions, the altered material (substantially a mixture of precipitated $CaCO_3$ and silica) possessed no power to enhance $CaCO_3$ concentration beyond the concentration attained by companion extractions of calcite.

The rapidity with which a calcium silicate can impart higher concentration of bicarbonate in carbonatated water is integrated with the readiness with which the silicate suffers hydrolysis, but the solvated silica is without apparent function. When the calcite, wollastonite, and slag were subjected to 4-hour agitated extractions in CO_2-free water, 10 grams per liter, their extracts had the respective pH values 9.3, 9.4, and 10.5, and titratable alkalinities rated as 1, 1.3, and 5, respectively.

Although variance in structure of a calcium silicate does not govern the ultimate concentration of calcium carbonate attained by the carbonatated water extraction, one type of silicate may undergo hydrolysis more readily and attain carbonatation more rapidly than another. Hence, when suspended in aqueous systems, wherein the proportion of carbonatated water to solid is preponderant and the pressure of CO_2 is relatively high, the slag and wollastonite behave alike in that they yield extracts that ultimately are of comparable concentration. Conversely, in the soil system, wherein the proportion of water to solid was less and the partial pressure of CO_2 was relatively low, the glassy and crystalline types of $CaSiO_3$ did not behave alike. When glassy silicates are incorporated in quantities in excess of those requisite for soil saturation, the excess quantities undergo carbonatation speedily. This obtained when quenched slag and fused-quenched wollastonite were incorporated with fallow and cropped soils (*10*). In contrast when correspondingly incorporated, the analogous crystalline forms of calcium silicate remained without showing any cumulation of $CaCO_3$.

The calcium carbonate solubility value plotted in Fig. 1 is concordant with values reported by Johnston (*2*), Leather and Sen (*3*), and Frear and Johnston (*1*). So far as is known to us, however, there is no record of calcium bicarbonate concentrations that approach those herein reported as having been attained through carbonatated water extractions of certain calcium silicates at room temperature and one atmosphere of CO_2.

The findings here reported and related observations are being pursued with the hope that they may be given practical application.

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The Habitat of the Snail Host of *Schistosoma japonicum* in the Philippines

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The wartime interest in schistosomiasis makes it timely to set forth some field observations on the habits and habitats of the intermediate host. In 1913 an investigator in Japan (*1*) incriminated a snail as the intermediate host of *Schistosoma japonicum*. A fresh-water form, at present designated as *Schistosomophora quadrasi* (Mollendorff), was reported by Tubangui (*2*) to be the intermediate host of the causative agent of schistosomiasis in the Philippine archipelago. With an increased amount of material available for examination, Bartsch (unpublished material) has shown *Schistosomophora hydrobiopsis*, often considered as a host in the central Philippines, to be synonymous with *S. quadrasi*.

S. quadrasi has been reported from eastern Leyte (Alangalong to Abuyog, inland to Dagami), eastern Mindoro, northeastern Mindanao, and all of Samar. There have been no reports of the species from Luzon, Panay, Negros, or Cebu. Observations reported herein were made primarily on southern Samar and around Palo, Leyte, during the early part of 1945.

Although the species is amphibious, its periods of terrestrial existence are not as prolonged as a review of the literature would indicate. The preference for an aquatic environment apparently is proportional to the temperature. These mollusks were found on the stems of emergent vegetation, particularly reeds, often as much as four inches above the water surface. However, this was true only in the early morning and in the cooler part of the evening. During the hotter part of the day they migrated beneath the water surface and were especially abundant in the shade of overhanging trees and shrubs. Collecting from emergent vegetation was not very profitable in the early afternoon. No observations were made as to their nocturnal locations. However, when placed in artificial containers indoors, the majority remained submerged and made little effort to leave the water.

Under natural conditions these snails were most frequently found in grassy ponds or slowly moving water. They do not normally live in swiftly flowing water, although floods may transport the debris to which they are attached great distances and into unnatural environments. They were abundant in the brown algal scum in the slowly flowing seepages from the banks of ponds and ditches. They seemed particularly to prefer, and were easily collected from, floating dead coconut fronds and partially submerged coconut husks. They apparently did not migrate into deep water, but could occasionally be collected from bottom debris and the surface of the mud in shallow bodies of water. No specimens were taken from wells. Contrary to expectations, rice paddies were not heavily populated by these snails.

The water in most of these habitats was found to have a pH of about 6.0 when tested with nitrazine indicator paper. The great amount of pollution and dead vegetation probably aids in maintaining this acidity. Some concept of the degree of pollution with human wastes might be obtained from the fact that in one area 36 per cent of the *S. quadrasi* examined contained developmental stages of human schistosomes.

Associated in the same habitats were *Melanoides turriculus* (Lee), *Physastra hungerfordiana* (Nevill), *Fossaria philippinensis* (Nevill), *Gyraulus quadrasi* (Mollendorff), and *Helicorbis mearnsi* (Bartsch). Determinations of all specimens were made by Dr. Paul Bartsch, of the Smithsonian Institution.

In general, it may be said that in the Philippines *S. quadrasi* occurs in shallow, quiet, or slowly flowing, polluted, acid water that contains an abundance of decayed organic matter, particularly coconut fronds. In such habitats they may be very abundant.

[1] The opinions expressed herein are those of the author and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

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Systolic Effect by Sulfhydryl Reagents[1]

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Considerable attention has been given in the past to the phenomenon of systolic standstill in the isolated frog heart which can be obtained with such diverse groups of substances as the cardiac glycosides, the veratrum alkaloids, ascorbic acid, the angelicalactones, and other oxidizing agents.

It has been demonstrated by the author (*3*) that cysteine and glutathione prevent the systolic standstill of the isolated frog heart caused by the oxidizing agents α–β and β–γ angelicalactone and *t*-butyl hydrogen peroxide. On the assumption that the –SH groups contained in cysteine and glutathione are responsible for this action, it was thought that specific

[1] The expense of this work was defrayed by a grant from the Ella Sachs Plotz Foundation. The author is indebted to Dr. E. S. G. Barron and to Dr. L. Hellerman for generously zoic acid. Thanks are also due to Parke Davis and Company supplying him with porphyrindin and *p*-chloromercuric benfor its generous supply of phenarsine oxide hydrochloride.

reagents which combine with the sulfhydryl groups of the sulfhydryl-containing enzymes would also bring about systolic standstill of the isolated frog heart. This assumption has been verified by the observations outlined below.

Use has been made in this investigation of the three types of sulfhydryl reagents used by Barron and Singer (*1, 4*) in the study of the role of sulfhydryl-containing enzymes in carbohydrate, fat, and protein metabolism and by Hellerman, Chinard, and Deitz (*2*) in their study of the reversible inactivation of urease. The isolated frog heart, mounted on a Straub-Fuhner cannula, has been subjected to the action of the following sulfhydryl reagents: (1) the oxidizing agents, porphyrindin and the sodium salt of *o*-iodosobenzoic acid; (2) an alkylating reagent, iodoacetamide; (3) mercaptide-forming compounds, the sodium salt of *p*-chloromercuric benzoic acid, and phenarsine oxide hydrochloride.

Porphyrindin in a concentration of 2×10^{-3} (7.5×10^{-3}M) causes an immediate systolic effect accompanied by a decrease in heart rate. Systolic standstill is brought about in a period of approximately 30 minutes. This effect is prevented when porphyrindin is dissolved in a solution of glutathione 6.5×10^{-3}M. Glutathione does not reverse the effect of porphyrindin once the systolic standstill has been achieved. Small concentrations of porphyrindin (up to 1×10^{-4}) cause temporary increase in the amplitude of contraction.

Ortho-iodosobenzoate in a concentration of 2×10^{-4} (8.3×10^{-4}M) causes systolic standstill in approximately 20 minutes, this effect usually being preceded by an increase in heart rate. A concentration of 1×10^{-4} to 0.5×10^{-4} causes a temporary increase in the amplitude of contraction.

Iodoacetamide in a concentration of 1×10^{-3} (5.3×10^{-3}M) brings about systolic standstill in a period of approximately 10 minutes. In one experiment a concentration of 1×10^{-4} caused no appreciable effect.

The study of the mercaptide-forming compounds presented more difficulties than that of the other two groups of reagents. Preliminary experiments show that systolic standstill is obtained with *p*-chloromercuric benzoate and with phenarsine oxide hydrochloride only under certain conditions.

Para-chloromercuric benzoate in concentrations of 1×10^{-5} to 1×10^{-4} causes a depressant effect which ends in diastolic arrest of the heart. Concentrations of 2×10^{-4} (5.6×10^{-4}M) produce a depressant effect of approximately one-minute duration followed by a gradually developing systolic effect, but before complete systolic effect is obtained, the heart stops beating. Complete systolic standstill can, however, be obtained when the heart is connected with an electrical circuit consisting of a platinum wire placed in the fluid of the Straub cannula and a cotton-wrapped copper wire, the cotton wick being placed in contact with the surface of the heart. The stimulating electrodes are connected through the output potentiometer of a condenser-discharge stimulator, thus closing the circuit of a voltaic cell. The reaction is obtained even when the stimulator is not operating.

Stoppage of the heart before achieving systolic standstill is also a troublesome matter when phenarsine oxide hydrochloride 1×10^{-3} (4.2×10^{-3}M) is applied. Complete systolic effect is obtained, however, when a clean, soft, copper wire, 0.025 inch thick, is placed in the fluid of the Straub cannula for a period of 40 to 60 minutes before applying the solution of the arsenical.

The interpretation of the results obtained with the mercaptide-forming compounds requires further investigation.

The preceding results show that certain sulfhydryl reagents cause systolic standstill of the frog heart. This investigation suggests the possibility of studying certain enzymatic reactions in the isolated frog heart, a living tissue.

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Reduction of Sympathetic Synaptic Transmission as an Index of Inhibition at Adrenergic Junctions in General[1]

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Physiological quantities of epinephrine have been shown to inhibit synaptic transmission in sympathetic ganglia (*7, 9*). Furthermore, drugs like ephedrine (*2, 3, 4*), which are dependent upon the presence of adrenergic fibers for the exercise of their major and typical actions, likewise produce inhibition at the synapses of sympathetic ganglia (*7, 10*). These findings agree in indicating that the synapses at which the inhibition in question takes place must be adrenergic and opposed to the cholinergic excitatory ones already known to function in sympathetic ganglia.

The action described therefore constitutes a means of studying sympathomimetic inhibition, e.g. by the amines, which has distinct advantages and avoids some of the drawbacks of methods hitherto available.

[1] Aided by grants from the Therapeutic Research Committee of the Council on Pharmacy and Chemistry of the American Medical Association.

The difficulties have been inherent in the use of smooth muscle as an indicator of drug action. Inhibition in such experiments has been followed by measuring the depression of pre-existing spontaneous activity. In the isolated preparation, the respective importance of myogenic and neurogenic factors in the mechanism of the spontaneous rhythmic and tonic activity of the muscle is uncertain and variable throughout each experiment as well as from one experiment to another. Consequently all the factors capable of modifying the pre-existing activity cannot be satisfactorily controlled. The multiplicity of factors responsible for motility in the isolated smooth muscle, and also the differing excitabilities of longitudinal and circular coats, is well illustrated in a recent analysis by Feldberg and Solandt (*5*). In experiments on the intact animal, on the other hand, the muscle is also subject to fluctuations in the number of sympathetic nerve impulses reaching it, as well as to regulation by the antagonistic parasympathetic innervation which may exercise at times an opposed, and at times a reciprocal, influence. The activity of neither nerve system is under the investigator's control and furthermore may even be an expression of drug action remote from the site under consideration or of compensatory reflexes initiated by the action of the amines anywhere in the body.

A further important factor is that some amines, e.g. ephedrine, tyramine, etc., may possess to a small but definitely complicating degree a direct (musculotropic (Tainter, *13*) exciting action on smooth muscle. This is most readily seen in the denervated preparation, but undoubtedly is present in the innervated tissue, where it obscures and reduces the apparent inhibition due to a true sympathotropic action. The interpretation of the smooth muscle record is thus complex and uncertain.

Barger and Dale (*1*) stated that "the accuracy with which inhibitor effects can be compared is, indeed, not sufficient to permit the assignment of exact ratios." Subsequent investigators have likewise suffered from the same handicap so that quantitative studies of sympathomimetic amines have for the most part been confined to pressor or excitatory actions while their inhibitory action, essential to the picture of sympathomimicity and therapeutically as important as the excitatory, has been comparatively neglected.

The present method of measuring inhibition is extremely sensitive[2] and is free from the above disadvantages. It consists in maintaining synaptic transmission through a sympathetic ganglion, in this instance the superior cervical, at a uniform testing level by preganglionic shocks. Thus, constancy of the activity to be inhibited is insured, since it is initiated by stimulating with fixed shocks the preganglionic nerve which has been isolated from the cord by section. The height of the potential recorded from the postganglionic nerve by means of suitable amplifiers (*8*) serves as a direct index of synaptic activity, and thus its reduction, when drugs are introduced intravenously, is a measure of inhibition. The action

TABLE 1

ORDER OF INHIBITORY ACTIVITY IN DIFFERENT TISSUES*

Ganglion	Intestine		Bronchi
(Cat)	Isolated (Rabbit) (*6*)†	Intact (Cat) (*15*)	(Guinea pig (*14*) and dog (*12*)
1. Epinephrine	Epinephrine	Epinephrine	Epinephrine
2. Nor-epinephrine	.....	Nor-epinephrine	Nor-epinephrine
3. Epinine			
4. Di-OH-ephedrine	.....	.....	Di-OH-ephedrine
5. Di-OH-nor-ephedrine	Di-OH-nor-ephedrine Epinine and tyramine	Di-OH-nor-ephedrine Epinine	Di-OH-nor-ephedrine
6. Meta-OH-nor-ephed.	Meta-OH-nor-ephed. Synephrine	.....	
7. Para-OH-nor-ephed.	Para-OH-nor-ephed.	.....	.....
8. Neosynephrine	.....	Neosynephrine	Neosynephrine Epinine
9. Tyramine		.....	.....
10. Phenylethanolamine	Phenylethanolamine and nor-ephedrine	.....	.....
11. Synephrine		Synephrine	.....
12. Amphetamine	.....	.....	
13. Ephedrine	Ephedrine	.....	Ephedrine
14. Nor-ephedrine		.....	Meta-OH-nor-ephed. Amphetamine Nor-ephedrine

* With respect to the same isomer in cases of stereoisomerism.
† Data on large intestine are presented since it gave "more uniform and sensitive responses." The results on small intestine were similar. ..... indicates absence from the series.

[2] The effect of 5 gamma of epinephrine injected intravenously in a 4-kg. cat can be easily detected.

so measured is strictly localized to the neuro-neuronal junction or ganglionic synapses and therefore cannot be obscured by musculotropic or other distant actions.

Although the various tissues innervated by sympathetic (adrenergic) inhibitory nerves have individual thresholds, together they constitute a group that typically is inhibited by average doses of epinephrine. Light would be shed both on the nature of the synaptic processes involved and on the applicability of the values obtained at the ganglionic synapses to other adrenergic neuro-effector junctions by a determination of the correspondence between values obtained for the same drugs at neuro-neuronal and at neuro-effector junctions. A final answer would depend upon the accumulation of considerably more extensive and diversified results, but a working answer suggests itself on comparing such data as are available. Table 1 presents, alongside the corresponding ganglionic data, results taken from the literature where experiments included a sufficient number of the amines in question to allow comparisons that begin to be significant. The four columns list in descending order, under the technique employed, the inhibitory potency of the amines tested. Taking into account the complicating factors already outlined, as well as species differences, a fair amount of agreement is apparent, particularly in that the most active and the least active compounds are in their approximately proper places. Four of the 14 compounds show frank discrepancies. These are epinine, tyramine, meta-OH-nor-ephedrine, and synephrine. In the case of epinine the isolated and intact intestine agree in placing it after cobefrine (di-OH-nor-ephedrine), whereas it precedes cobefrine in the ganglionic series. This difference, however, is no more marked, in fact less so, than that for the order of epinine in the two intestinal compared to the bronchial series. Tyramine shows a more serious difference but unfortunately is only represented in two series and so cannot be analyzed further. With meta-OH-nor-ephedrine, results in the ganglion and the isolated intestine agree well with each other but not with those in the bronchi. Finally, while the ganglionic synephrine value differs from that of the isolated intestine, it agrees well with that of the intact intestine. Even when there is noteworthy disagreement (4 out of 14) the agreement between the ganglionic and any of the other three series is no poorer than that among the non-ganglionic series themselves. Though each tissue is characterized by its own individual threshold, the comparative inhibitory activity of sympathomimetic amines at adrenergic neuro-effector and adrenergic ganglionic junctions appears to be, from such comparisons as are possible at present, of about the same order. Thus, in assaying the inhibitory action of amines, the ganglion, as much as one tissue can, may be taken as reasonably representative of adrenergic inhibitory junctions in general.

The comparisons favor the author's previously expressed contention that adrenergic (*11*) (and also cholinergic, *8*) processes at the neuro-neuronal junctions, represented by the synapses of sympathetic ganglia, and at neuro-effector junctions are essentially the same with only quantitative differences such as already exist between the various neuro-effector junctions themselves.

The point of view and method described have been found particularly useful in studying the relation between the structure and preponderance of inhibitory activity in sympathomimetic amines. Since both excitatory and inhibitory activities of the sympathomimetic amines are simultaneously influenced by the structure, correlation was attempted with both types of activity at once, as expressed by the ratio of inhibitory potency, measured in a reliable fashion such as described above, to excitatory potency. The correlation so obtained was attended with a greater degree of success than would otherwise have been possible. Moreover, this ratio, indicating the preponderance of inhibition or excitation, is exactly the knowledge desired for many therapeutic uses where the best drug would be the one most nearly manifesting a pure or exclusively inhibitory or excitatory action. A detailed presentation of the results is in preparation.

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In the Laboratory

Mixtures of Solid Amino Acids for Microbiological Amino Acid Assay

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Microbiological procedures for the assay of amino acids in proteins, foods, and physiological fluids have been available for only about three years, yet they are employed routinely today in numerous laboratories. It is desirable, therefore, that the manipulations be made as simple as possible.

Techniques which have been employed advantageously in the authors' laboratory include the use of (a) a cover of heavy toweling for each rack of about 300 tubes in place of a cotton plug or metal cap for each test tube; (b) an automatic pipette instead of hand pipettes for the transfer of media, samples, distilled water, and cultures of microorganisms; and (c) solutions of mixtures of, rather than individual, amino acids. According to McMahan and Snell (*1*) and Stokes and Gunness (*4*), amino acid solutions are stable for several months when covered with a layer of toluene and stored in brown glass-stoppered bottles in the refrigerator. The present authors have observed that no change in concentration of amino acids in such solutions occurred in nine months. Lyophilized cultures of the lactobacilli *arabinosus* and *casei* have been utilized for the assay of vitamins by Nymon, *et al.* (*2*), and lyophilized basal media have been used for the same purpose by Spitzer, *et al.* (*3*). The latter have stated that lyophilized media for the assay of amino acids were in process of preparation.

It has been found that solid mixtures containing accurately weighed quantities of crystalline amino acids, which have been transformed to a homogeneous powder, may be employed conveniently in the preparation of basal media. Such mixtures may be prepared by placing the weighed amino acids in rubber-stoppered glass bottles and rotating the bottles in a ball mill. Quantities of powdered mixtures up to 40 grams have been prepared by rotating for 45 minutes a pint bottle containing the amino acids and six porcelain balls. The amino acid powders were not noticeably hygroscopic, and they have been found to be stable for at least six months when preserved in glass-stoppered bottles. Mixtures containing 15 to 18 amino acids have been employed successfully in the quantitative determination with *Leuconostoc mesenteroides* P-60 of arginine, cystine, histidine, isoleucine, leucine, lysine, and valine.

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Demonstration of the Bronchial Tree and Pulmonary Blood Vessels in the Fetal Pig

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By a very simple and easy procedure the bronchial tree and pulmonary blood vessels of the fetal pig may be freed from other lung tissue and revealed with surprising clarity and completeness of detail. The method is so simple it has been incorporated into the routine laboratory study of the fetal pig in our classes in elementary biology.

The pigs used are embalmed, uninjected specimens around 8 to 11 inches in length, obtained from a supply house. The lungs are removed from the body, with trachea attached, and then by the simple expedient of crushing and squeezing them in the hand and rubbing them gently between the fingers, with an occasional rinse in water, the parenchyma of the lung is gradually broken up and washed away, leaving intact all but the minute subdivisions of the bronchial and vascular systems. This process should not be hurried, and 30 minutes or more may be required to clear away the parenchyma. In breaking up, the lung tissue separates mainly along the boundaries of the secondary lobules, and the latter, or their fragments, then break away from their bronchial and vascular connections. The ultimate portions of the latter systems are carried away in the lung fragments. When virtually all of the lung tissue has been cleared away from the vessels, the preparation is floated in water and denuded of the last bits of parenchyma, strips of pleura, etc., with forceps.

When floated in water, the air and blood vessels tend to resume their natural positions, and one is able to observe their ramifications and distribution in a striking and vivid manner. The terminal twigs of the systems range almost to the limit of naked eye visibility.

One may now separate arteries, veins, and bronchial tree so that each may be viewed in isolation. In the laboratory, this step is usually done for the students simply by stripping blood vessels off the bronchial tree rapidly with forceps. This may result in a good deal of breakage of blood vessels, but the very apparent differences between arteries and veins may be pointed out. With careful and patient use of needles and forceps, however, it is possible to isolate the complete system of pulmonary arteries, and of pulmonary veins, each separate and intact. To accomplish this it is necessary, of course, to use a preparation in which the pulmonary artery has been severed close to the heart, and in which the proximal connections of the veins have been preserved by removing with them a part of the wall of the left auricle. The isolated arterial and venous systems, as well as the bronchial system, make striking demonstration specimens and may be mounted in formalin in museum jars for permanent display.

This method has obvious advantages over that of corrosion preparations, particularly in that, instead of casts, the various vessels themselves, with their noticeable differences in characteristics, are demonstrated. A more complete account of methods, with photographs of preparations, will be published elsewhere. The applicability of the method to the human lung is under investigation.

News and Notes

Editorial Announcement

In January of this year it appeared that conversion from a wartime basis was pretty well under way and that the year 1946 would see a return to fairly normal peacetime supplies of all kinds, including paper. We consequently made our plans to publish 48 pages in each issue of *Science* and also planned at least four special issues during the year, each one of which would consist of at least a hundred pages.

Time made it clear that paper supplies would not be available to consummate this plan, and as a consequence, we were forced to reduce the size of an issue to 32 pages on 24 May. With only minor modification we have remained at this level until the present issue, which contains an index for Volume 103. With the 12 July and succeeding issues, we shall have to drop back to the thirty-two page level again.

The reduction in size is shared equally between the advertising pages and the editorial content, and in order to conserve our regular book paper for the editorial section and the index, we used color stock for some of the advertising pages.

The first six months of 1946 saw the sudden declassification of a considerable amount of wartime research, resulting in a flood of manuscripts which we would not have been able to accommodate even though we were not faced with a paper shortage. Today the situation is so critical that manuscripts which were accepted in the faith that publication would normally take place within a reasonable time have had to be deferred beyond the expectation of the authors and editor.

During this critical period it is absolutely essential that authors use every means of making their papers as brief as possible. In some cases we have been forced to return papers that were already accepted for even further shortening.

The editor contemplates with distaste the unpleasant task of having to reject many worthy papers in the next six months due to previous commitments and inadequate paper supplies.

Science stands ready to relinquish all priority to papers now waiting in our files for publication if the author can find a suitable medium for prompter publication.

Announcements

Important changes in organization of the National Research Council were announced by Frank B. Jewett, president of the National Academy of Sciences, 28 June. Effective from 1 July, 1946, the following appointments have been made of administrative officers in the National Research Council:

Chairman of the Council: Detlev W. Bronk, director, Johnson Foundation for Medical Physics, University of Pennsylvania, to succeed Ross G. Harrison, Yale University—term expired.

Chairman, Division of Medical Sciences: Lewis H. Weed, director, School of Medicine, Johns Hopkins University, on a full-time basis, to succeed himself.

Chairman, Division of Physical Sciences: R. Clifton Gibbs, Department of Physics, Cornell University, to succeeed L. P. Eisenhart, Princeton University—term expired.

Chairman, Division of Chemistry and Chemical Technology: Louis P. Hammett, Department of Chemistry, Columbia University, to succeed W. Mansfield Clark, Johns Hopkins University—resigned.

Chairman, Division of Geology and Geography: Arthur Bevan, State Geologist of Virginia, Charlottesville, to succeed William W. Rubey, U. S. Geological Survey—term expired.

Chairman, Division of Biology and Agriculture: Robert F. Griggs, Department of Botany, George Washington University, to succeed himself.

Chairman, Division of Anthropology and Psychology: A. Irving Hallowell, Department of Anthropology, Northwestern University, to succeed Walter R. Miles, Yale University—term expired.

In addition, Frederick M. Feiker, George Washington University, will continue as chairman of the Division of Engineering and Industrial Research under his present appointment.

Also as foreign secretary of the National Academy of Sciences, Detlev W. Bronk will continue ex officio as chairman of the Division of Foreign Relations.

Dr. Harrison, who has served as chairman of the Council with great distinction for nearly eight and a half years on a part-time basis, will return to the Osborne Laboratory at Yale.

In accepting the chairmanship as Dr. Harrison's successor, Dr. Bronk has relinquished a large part of his responsibilities at the University of Pennsylvania so as to be able to devote the major part of his time to administering the affairs of the Council. The Council is thus assured of what is essentially full-time administration of its operations—something which the largely expanded work of the Council demands.

For the moment the Division chairmanships, with the exception of the Division of Medical Sciences, will continue on a part-time basis. In the case of the latter Division, however, the load of present and prospective demands for National Research Council assistance to Government and private agencies is so great as to require full-time supervision. In consequence, Dr. Weed has agreed to relinquish his duties at Johns Hopkins Medical School and devote his entire time to the administration of the Division.

For the time being and until his successor is elected Dr. Bronk will continue as foreign secretary of the National Academy of Sciences.

The Science Section of the Minnesota Independent Citizens' Committee of the Arts, Sciences, and Professions unanimously passed a resolution, dated 13 June, supporting the new bill, H.R. 6672 (*Science*, 28 June, 753), introduced by Representative Celler, which is identical with the Senate bill, 1850. The resolution pointed out that the bill, H.R. 6448, "fails to provide for equitable geographic distribution of funds; does not seem to provide for minority reports by the commission responsible for the administration of the funds; supports certain patent-right provisions detrimental to the public welfare."

Copies of the resolution were mailed to Chairman Priest, of the Interstate and Foreign Commerce Committee; Representative Mills, who introduced H.R. 6448; and Representative Celler, as well as the Minnesota Representatives in the House and Senators Kilgore and Magnuson.

The covering letter criticized the National Academy of Sciences saying that, ". . . it is not representative of American Scientists. It is, instead, a restricted group of self-selected scientists which has a record of inaction and favoritism which has caused the majority of American scientists to distrust it deeply. If H.R. 6448 is enacted into law, this country will suffer from the perpetuation of the policy of pouring money into the old, 'respectable' institutions, largely in the East, while the Middle West, South, and West will continue to hold the bag."

A $1,000 prize for newspaper science writing each year has been announced, to be administered by the AAAS, through a grant of funds from the Westinghouse Educational Foundation in celebration of the centennial of the birth of George Westinghouse. The purpose of the award is to encourage better science reporting in newspapers. It is believed that this contest will be a permanent program.

The deadline for this year's contest is 15 October. Information and entry blanks may be obtained by writing to the Chairman, Managing Committee, AAAS–George Westinghouse Science Writing Awards, Smithsonian Institution Building, Washington 25, D. C.

The Columbia Broadcasting System announced on 6 May that the Federal Telecommunication Laboratories, Inc., affiliate of the International Telephone and Telegraph Corporation, has been licensed to manufacture television transmitter equipment based on CBS' ultrahigh-frequency color television inventions. Federal Laboratories is the second major firm licensed under Columbia's color-television invention patents.

Provisions of the agreement between the two companies parallel the contract signed two months ago with Westinghouse Electric Corporation. Both arrangements are on a patent royalty basis of one per cent to CBS on the manufacture of television transmitter equipment, and cover a five-year period with options for extension.

The psychological effects of frontal lobotomies are being investigated by the Department of Psychology of the University of Pittsburgh under a grant from the U. S. Public Health Service. The research program is being conducted jointly by Y. D. Koskoff, neurosurgeon, Montefiore Hospital; Victor C. Raimy, assistant professor of psychology, University of Pitts-

burgh; and Erma Wheeler, instructor in psychology, University of Pittsburgh.

The Institute of Polymer Research at the Polytechnic Institute of Brooklyn announces the following summer laboratory clinics for 1946: "Weight and Shape of Polymer Molecules in Solution," 24–28 June and 15–19 July (two sessions); "Industrial Applications of X-ray Diffraction," 12–23 August; "Advanced X-ray Diffraction Course," 26–31 August; and "The Preparation of High Polymers in Bulk, Solution, Suspension, and Emulsion," 2–6 September.

Credit may be arranged for most of these clinics for those attending the course in the graduate curriculum. The laboratory fees for the various clinics will range from $100 to $200. Since the attendance will be limited to from 10 to 20 in the clinics, those interested are asked to register early by writing to the Institute of Polymer Research, 99 Livingston Street, Brooklyn 2, New York.

The Institute offers to assist registrants in finding convenient accommodations.

The Samuel S. Fels Fund of Philadelphia announces the erection of a new research laboratory building on the Antioch College Campus at Yellow Springs, Ohio. The new building, to cost about $400,000 exclusive of equipment, is to house the activities of the Fels Research Institute. The Institute's program, devoted to the study of growth and development of children, is being expanded considerably in the following areas: biochemistry with emphasis on blood and urinary enzymes, vitamin adequacy, ketosteroids, estrogens and other hormones, in relation to growth progress and behavior; genetics with emphasis on the inheritance of biochemical and physiological function patterns and growth patterns; physiology with emphasis on resistance level to physical or emotional stress in relation to predisposition to psychosomatic disease and personality.

To house these activities and those of the psychology and physical growth sections, physiological, physical growth, biochemical, and psychological laboratories, as well as office and library space, will be provided.

Six internships have been created, to be available annually to graduate students working toward advanced degrees in any accredited university in the fields of psychology, psychophysiology, physical growth, and biochemistry. These will provide an annual stipend of $1,200.

A new scientific advisory board has been created, consisting of: Robert Yerkes, Yale University, psychobiology; Ashley Weech, Cincinnati University, pediatrics; E. V. Cowdry, Washington University, anatomy; and Maurice Visscher, University of Minnesota, physiology. The Institute, established in 192 is under the direction of L. W. Sontag.

The new Desmond Arboretum at Newburgh, Ne York, temporarily closed during the war period, wi from now on be open again daily, free of charge, t interested visitors. Those wishing to inspect thi arboretum can obtain permission by writing or calling at the office of New York State Senator Thomas C Desmond, 94 Broadway, Newburgh, New York, or b contacting the arboretum superintendent, Rudolph M Nocker.

Started in 1939, the arboretum now contains 49 species of trees and shrubs. Senator Desmond is endeavoring to include in this arboretum all nativ American trees and shrubs which may prove hard in the Newburgh, New York, climate, together wit some of the more interesting or more ornamenta foreign trees and shrubs.

A research unit affiliated with the Institutum Di Thomae was dedicated at the College of Saint Mar of the Springs, Columbus, Ohio, on 9 May. The prin cipal address, "Research in the Liberal Arts College," was delivered by Elton S. Cook, dean of research o the Institutum Divi Thomae, Cincinnati.

The Tercentenary of Sir Isaac Newton's birth wi be celebrated in London, 13–20 July. In response t the invitation of the Royal Society, London, the fo lowing have been appointed as delegates to represe the National Academy of Sciences upon this occasio Walter Adams, Marston Bogert, Frederick E. Brase Leonard Carmichael, Leslie Dunn, Jerome Hunsake Herbert Ives, Walter R. Miles, Peyton Rous, an Theodor von Kármán.

The International Congress of the Anthropologica and Ethnological Sciences, which last met in Cope hagen in 1938, has been reconstituted by a well-at tended meeting of the Permanent Council, at Ne College, Oxford, 13–15 April, and at the Royal An thropological Institute, London, 16–18 April.

At the final business session of the Council, at tended by 34 delegates, it was voted to hold the nex or third, session of the Congress in Czechoslovak during August 1947. Runners-up in the selectio were Portugal and Mexico, with Belgium and Turke extending contingent invitations in case the date wer postponed to 1948.

The will to postwar scientific rehabilitation i Europe was encouragingly manifest in the attitud as well as by the attendance of the delegates.

Those present included: Alföldi (Hungary); Birket Smith (Denmark); Breuil, Leroi Gourhan, Rivière and Vallois (France); Charles, de Jonghe, and O brechts (Belgium); Felhoen Kraal, Fischer, and Jan

sen (Netherlands); Gabus (Switzerland); Genna and Sergi (Italy); Kansu (Turkey); Kroeber (United States); Lindblom (Sweden); Macalister (Eire); Myres, Childe, Hutton, and Radcliffe-Brown (Britain); Schmidt (Vatican City); Spry (Canada); Stolyhwo (Poland); Tamagnini (Portugal); and Valsik (Czechoslovakia).

In addition to reports from six committees of the Congress, a number of scientific papers were presented, including the deferred Huxley Memorial Lecture for 1941 of the Royal Anthropological Institute, by Abbé H. Breuil on "The Discovery of the Antiquity of Man."

The State-owned Swedish research ship, "Skagerack," which has been placed at the disposal of the Swedish Marine-Biological Commission, recently left Gothenburg for a three-month cruise in the Mediterranean. The main task of this expedition is to take samples of the bottom sediments in various parts of the Mediterranean off the port of Algiers and probably also east of Malta.

These investigations form the first link in extensive Swedish research work which aims at shedding light on the climatic and volcanic catastrophes of past ages. It is also expected that the study of the old bottom layers of the oceans, dating back many millions of years, may tell the story of the ancient transatlantic plateaus over which animals and plants once spread from continent to continent.

Hans Pettersson, head of the Oceanographical Institute in Gothenburg, is the leader of this first expedition, in which 6 scientists are participating in addition to the crew of 21. The scientists will have an opportunity to test a new instrument, the vacuum plummet, by which they expect to take up 20-meter-deep samples of the bottom sediments.

It is hoped that these investigations in the Mediterranean will prove of value in preparing for the large-scale oceanographic expedition which the above-mentioned Swedish institute will start in the spring of 1947. This deep-sea expedition, which will circumnavigate the globe during a 15-month voyage, is to be undertaken on board the 1,100-ton training ship, "Albatross," which has been placed at the disposal of the Swedish Broström Concern. Other Swedish shipping companies have also contributed to the financing of the expedition.

The research work of the "Albatross" expedition will be carried on chiefly in the tropical zone within the areas of the equatorial countercurrent. Among the places to be investigated in the Atlantic is the Puerto Rico Deep of 9,000 meters and, in the Pacific, the remarkable Philippine Depths of 10,500 meters.—*The Swedish-International Press Bureau.*

The National Research Council, through its Fellowship Board in the Natural Sciences, has made the following fellowship appointments for the academic year 1946–47:

Mary Belle Allen (candidate for Ph.D. in chemistry, Columbia University, 1946), to study at Washington University.

James R. Arnold (Ph.D. in chemistry, Princeton University, 1946), to study at Harvard University.

Earlene Atchinson (candidate for Ph.D. in botany, University of Virginia, 1946), to study at the Atkins Institution of the Arnold Arboretum (Harvard University).

Jule G. Charney (candidate for Ph.D. in meteorology, University of California at Los Angeles, 1946), to study at the University of Oslo.

Robert D. Cowan (candidate for Ph.D. in physics, Johns Hopkins University, 1946), to study at the University of Chicago.

Bernard Hamermesh (Ph.D. in physics, New York University, 1944), to study at California Institute of Technology.

Ralph T. Holman (Ph.D. in physiological chemistry, University of Minnesota, 1944), to study at the Medicinska Nobelinstitutet.

Henry Kritzler (Ph.D. in zoology, State University of Iowa, 1942), to study at the Scripps Institution of Oceanography (University of California).

Paul M. Marcus (Ph.D. in chemical physics, Harvard University, 1943), to study at Massachusetts Institute of Technology.

Donald S. Miller (Ph.D. in mathematics, Cornell University, 1941), to study at Yale University.

John M. Reiner (candidate for Ph.D. in physiology, University of Minnesota, 1946), to study at Washington University.

Adrian M. Srb (candidate for Ph.D. in biology, Stanford University, 1946), to study at California Institute of Technology.

Walter C. Strodt (Ph.D. in mathematics, Columbia University, 1939), to study at Harvard University.

Merle E. Tuberg (Ph.D. in astronomy, University of Chicago, 1946), to study at Girton College (University of Cambridge).

Robert P. Wagner (Ph.D. in zoology, University of Texas, 1943), to study at California Institute of Technology.

Sherrerd B. Welles (Ph.D. in physics, Yale University, 1941), to study at Cavendish Laboratory (University of Cambridge).

Arthur H. Whiteley (Ph.D. in zoology, Princeton University, 1945), to study at California Institute of Technology.

Robert W. Wilson (Ph.D. in paleontology, California Institute of Technology, 1936), to study at California Institute of Technology.

Frank B. Wood (Ph.D. in astronomy, Princeton University, 1941), to study at the Steward Observatory (University of Arizona).

Elections

The American Rocket Society, national association of rocket and jet-propulsion engineers, has announced the election of Lovell Lawrence, Jr., as its president for 1946–47. Mr. Lawrence, pioneer rocket engineer and long a member of the Society, is president of Reaction Motors, Inc., of Pompton Plains, New Jersey, now heavily engaged in the development of liquid-fuel rocket motors in connection with the Navy and Army jet-propulsion and guided missile program.

The new vice-president is Roy Healy, jet-propulsion project engineer of the Air Technical Service Command. Mr. Healy is engaged in military rocket development at the Rocket Experimental Station, Dover, Delaware. Active in rocket development since before the war, he has been a member of the Society for more than 10 years.

The new secretary is G. Edward Pendray, pioneer rocket engineer and co-designer with H. F. Pierce of the Society's first liquid-fuel rocket in 1932. Mr. Pendray was one of the founders of the Society in 1930.

Hans Thatcher Clarke, biochemist, College of Physicians and Surgeons, Columbia University, was chosen chairman-elect of the American Chemical Society's New York Section at the Section's annual meeting in the Hotel Pennsylvania, 7 May.

The Virginia Academy of Science held its 24th annual meeting in Richmond on 9–11 May, under the leadership of President H. Rupert Hanmer, director of research for the American Tobacco Company. Officers elected for the coming year are: Jesse W. Beams, professor of physics at the University of Virginia, president-elect; E. C. L. Miller, directing librarian at the Medical College of Virginia, secretary-treasurer; George W. Jeffers, professor of biology at Farmville State Teachers College, assistant secretary; and Edward S. Harlow, of the American Tobacco Research Laboratory, new member of the Council. Arthur Bevan, state geologist of Virginia, was installed as president for 1946–47.

Over 600 members were in attendance, 150 papers were presented in the 10 sections, and 15 winners of the Virginia Science Talent Search, the first of its kind on a state level, were entertained by senior members of the Academy. Margaret E. Patterson, secretary of Science Clubs of America, was the principal speaker at the banquet and presented awards of War Savings Bonds on behalf of the Academy to the talent search winners. Scholarships valued at $30,000 have been offered these high school seniors by various colleges of the country. A meeting of the Junior Academy of Science, attended by 50 juniors, was held concurrently with the senior meeting.

The Wisconsin Academy of Sciences, Arts, and Letters held its 76th annual meeting on 12 and 13 April at the University of Wisconsin, Madison. The following were elected to office for 1946–47: L. E. Noland, Department of Zoology, University of Wisconsin, president; E. L. Bolender, Superior State Teachers College, vice-president in science; John Steuart Curry, artist-in-residence, University of Wisconsin, vice-president in arts; Robert K. Richardson, Beloit College, vice-president in letters; Banner Bill Morgan, Department of Veterinary Science, University of Wisconsin, secretary-treasurer; H. O. Teisberg, Historical Library, Madison, librarian; W. C. McKern, Milwaukee Public Museum, curator; and Banner Bill Morgan, University of Wisconsin, representative on the Council of the AAAS.

The following were elected to life membership: Charles E. Allen, University of Wisconsin; Ruth Marshall, Wisconsin Dells; William S. Marshall, University of Wisconsin; Edward R. Mauer, Richard Fischer, and Frederick E. Turneaure, Madison. The following were elected to honorary membership: Frank Lloyd Wright, architect; Alexander Wetmore, ornithologist; and Ester Forbes, writer.

A total of 20 papers were presented at the regular Academy session, 9 papers in the American Chemical Society Section, 15 papers in the Archeological, Folklore, and Museum Section, and 8 papers in the first Junior Academy section.

H. A. Schuette, in his presidential address, told of the progress which has been made in the prevention of adulterated foods and drugs. Guest speakers in social science were invited. John H. Kolb spoke on the "Background and Foreground of Wisconsin's Rural Communities"; L. A. Salter, on "Do We Need a New Land Policy?"; and Scudder MeKeel, on "Where is Social Science?"

The New York State Geological Association held its 18th meeting, the first since the war, on 10–11 May at Vassar College. Daniel T. O'Connell and Cecil H. Kindle, of the Geology Department of the College of the City of New York, were elected president and secretary of the Association, respectively, for 1946–47.

The first day was devoted to the folded Silurian and Devonian beds of the Kingston-Rosendale region; the second, to the increasing metamorphism of the Cambro-Ordovician sediments eastward from Poughkeepsie.

Sixteen different institutions contributed to the attendance of 110 persons. The next annual meeting will take place in New York City in the spring of 1947.

The Hawaiian Academy of Science held it 21st annual meeting 9–11 May, at the University of Hawaii, Honolulu. The following officers were elected for the year 1946–47: T. A. Jaggar, University of Hawaii, president; Harold St. John, University of Hawaii, vice-president; Chester K. Wentworth, Board of Water Supply, secretary-treasurer; Christopher J. Hamre, University of Hawaii, Joseph P. Martin, Hawaiian Sugar Planters Association, and Peter H. Buck, Bishop Museum, councilors.

The first two evenings were devoted to scientific papers. The annual dinner and business meeting were held on the last evening, followed by the address of the retiring president, Peter H. Buck, who spoke on "The Place of Hawaii in Pacific Research."

The Franz Theodore Stone Laboratory of Ohio State University, at Put-In-Bay, will begin its 50th summer on 17 June, according to the summer-quarter bulletin just issued. Advanced courses in the Departments of Botany, Chemistry, Entomology, Geography, and Zoology are to be offered to qualified students and research workers.

Recent Deaths

James P. Schooley, 42, assistant professor of anatomy in the Wayne University College of Medicine, died on 23 June.

Roswell P. Angier, 71, professor of psychology and director emeritus of the psychology laboratory at Yale University, who retired in 1941 after thirty-five years on the faculty, died in Tucson, Arizona, on 24 June.

Permian Studies at the Smithsonian Institution, Washington

The major postwar program of the Division of Invertebrate Paleontology and Paleobotany (Department of Geology) of the Smithsonian Institution is a thorough investigation of the invertebrate faunas of the Permian period. These studies will be based on collections from the Glass Mountains, Brewster County, Texas, but borrowed material from other parts of the country will be included. The majority of the specimens to be studied are silicified and will be freed by dissolving them out of their calcareous matrix.

In announcing this program we are heralding a plan already in full swing. In the beginning it was a modest scheme to investigate levels in the Permian of the Glass Mountains in order to determine the quality of the silicification and the best localities for fossils. The success of this preliminary work led to the present intensive program. In some five years the Smithsonian Institution should have a collection of many thousands of specimens of exquisitely preserved fossils; the faunas of the Wolfcamp, Leonard, and Word should become the best-known Paleozoic assemblages on the continent. Although the solution program is supported by the Smithsonian Institution, part of the field work was sponsored jointly by the U. S. Geological Survey and the Smithsonian Institution.

The present program was initiated in 1939 by Cooper when he and Josiah Bridge visited the Glass Mountains to obtain certain brachiopods then unrepresented in the National collections. The results of this visit were so gratifying that Cooper returned there the following year. Armed with a good counsel on promising localities from Philip B. King, U. S. Geological Survey, he collected more than a ton of blocks. During the fall and winter of 1940 nearly all of the blocks were dissolved. Unbelievably fine specimens of most of the invertebrate phyla were obtained.

Inasmuch as the possibilities for collecting and understanding the Permian fauna seemed limitless, several specialists were invited to join the study. Accordingly, the pelecypods were referred to N. D. Newell, then at the University of Wisconsin but now of the American Museum of Natural History. Several lots of cephalopods were sent to A. K. Miller, of the University of Iowa. The gastropods were turned over to J. Brooks Knight, then at Princeton University and now of the U. S. National Museum, who added to these a collection of similarly preserved and prepared gastropods from the Permian of the Sierra Diablo Plateau, Hudspeth-Culberson Counties, Texas, on which he was at work. The trilobites were referred to J. Marvin Weller, of Chicago University.

In the summer of 1941 Cooper and Newell, under a grant from the Smithsonian Institution, spent six weeks collecting from all parts of the Glass Mountains. This expedition resulted in an accumulation of four and one-half tons of blocks of which three-fourths of a ton was sent to Newell at Madison, Wisconsin, and the remainder to Washington. Newell dissolved all of his blocks and obtained from them an incomparable collection of pelecypods and gastropods. Scarcely a quarter of Cooper's material was prepared before the program was sent into low gear by the war.

In the spring of 1945 R. C. Moore joined the program and took over work on the crinoids, corals, and bryozoans. That summer another expedition to the Glass Mountains, sponsored jointly by the U. S. Geological Survey and the Smithsonian Institution and consisting of Moore, Knight, and Cooper, spent six weeks accumulating some seven tons of blocks, many of them of large size and some exceeding 100 pounds. Most of these are to be processed in the Smithsonian Institution, but Moore at Lawrence, Kansas, will dis-

solve more than two tons of blocks that he collected.

The original work of solution was carried out in miscellaneous glassware vessels up to a capacity of 5 gallons. Finally, a stone tub holding about 70 gallons was installed in the National Museum. Present plans call for increasing the facilities to three tubs. The new equipment will be capable of digesting some seven tons of blocks in four or five years.

The modest but persistent solution program carried on since 1939 has already yielded an important collection occupying some 270 trays (22½ in. × 28¼ in.). Brachiopods are the most abundant fossils freed from the blocks from all parts of the Glass Mountains. These specimens are of especial importance because of their perfect preservation. Modern generic splits of the productids have been denounced by some paleontologists, but this program is yielding new evidence supporting the validity of many of them and also of additional new genera. Specimens of *Krotovia, Yakovlevia, Dictyoclostus, Aulosteges, Avonia, Waagenoconcha, Linoproductus,* and *"Marginifera"* with virtually all spines in place give a new conception of these odd brachiopods. Definite information as to the living habits of these animals and the meaning of their spines has already been obtained. About 75 brachiopod genera and some 200 species occur in the collection. Knight estimates 250 new species and 100 genera, about half of them new, among the gastropods. Miller has already described many of the cephalopods taken from the blocks. The pelecypods, corals, bryozoans, and sponges are equally well preserved. Chitons, trilobites, scaphopods, and remains of other groups are less abundant. Growth series of many species have been taken. By the time the solution program is completed, sufficient material will have been accumulated for statistical studies of many species.

The Smithsonian program will require about five years to dissolve all blocks on hand. While the acid is simmering, the men working on the individual projects will sort and study the accumulating material as follows: bryozoans, crinoids, and corals—Moore; brachiopods—Cooper; gastropods—Knight; pelecypods—Newell; cephalopods—Miller; and trilobites—Weller.—*G. Arthur Cooper* and *J. Brookes Knight* (U. S. National Museum).

Letters to the Editor

Commercial Fertilizer in the Culture of Fresh-water Algae

The culture of *Chlorella, Nitzschia closterium,* and *Prorocentrum triangulatum* in media containing small amounts of commercial fertilizers was reported by Loosanoff and Engle (*Science,* 1942, 95, 487–488), who found that complete fertilizers of the formulas 5–3–5 and 6–3–6 gave the best results. Recently Strickland (*Science,* 1946, 103, 112–113) advocated the use of fertilizers of these formulas in the culture of marine algae (*Nitzschia, Navicula, Spirulina subsalsa,* and *Lyngbya semiplena*). Loosanoff and Engle used 1.0 gram of fertilizer in 1,000 cc. of sea water, although concentrations as dilute as 1: 10,000 were found satisfactory. Strickland employed 0.5 to 1.0 gram per liter.

We have used commercial fertilizer in the culture of a number of fresh-water algae for the past 18 months. All of the forms given below were maintained in unialgal culture for that period with little difficulty. After preliminary tests 1.0 gram of fertilizer per liter of spring water (or distilled water) was chosen as most favorable for the growth of a variety of algae. Several fertilizers of different formulas were tested, but 4–10–4 appeared applicable to the culture of more species than any other.

One gram of fertilizer was shaken well with 1 liter of spring water. The mixture was heated to 80° C., shaken again, and filtered while hot through filter paper (Reeve Angel, No. 201). The clear filtrate was poured in 200-cc. lots into ordinary finger bowls, which were then placed in a hot-air oven and pasteurized. After cooling to room temperature the medium was inoculated with the desired organism, and then the bowls were covered and placed in the light of a west window.

Generally, depending largely on the amount of light and temperature, these cultures attained a maximum development in a period varying from two to four weeks and remained in a productive state for several weeks longer. Subcultures were prepared at intervals of two or three weeks.

The following organisms were found to grow luxuriantly in the fertilizer medium: *Euglena deses, Chlamydomonas monadina, Pandorina morum, Eudorina elegans, Gonium pectorale, Chlorococcum, Zygnema, Spirogyra* (species with single chloroplast), *Stigeoclonium,* and numerous unidentified species of diatoms and desmids in mixed culture. *Ulothrix, Mougeotia, Pithophora,* and *Melosira* were cultivated for periods up to two months, but eventually died out. *Euglena spirogyra, E. oxyuris, Oscillatoria, Vaucheria, Volvox aureus, Oedogonium, Nitella, Chara,* and several species of dinoflagellates would not grow in the fertilizer medium. The desmids, *Hyalotheca* and *Closterium,* grew well only if distilled water replaced spring water. The alga-bearing ciliate, *Paramecium bursaria,* was cultured successfully for many months, but opposite mating types would not conjugate

on mixing, although branch lines of the two clones conjugated readily when grown in another medium.

Fertilizer medium (1) is inexpensively and easily prepared, (2) will support the growth of a variety of freshwater algae, (3) produces large quantities of organisms in a short period of time, and (4) yields cultures relatively free of bacterial growth.

The author is indebted to the Smith-Douglass Company, Inc., Norfolk, Virginia, for the various fertilizers used in his experiments.

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Misuse of the Linnaean System of Nomenclature

In a recent paper by E. E. Dickerman on "The morphology and life cycle of *Proterometra sagittaria* n.sp., (*Trans. Amer. Soc.*, 1946, **65**, 37), the larval form of a trematode is described and assigned a binary name of the Linnaean system (*Cercaria sagittaria* Dickerman), while the adult is described and given another Linnaean name (*Proterometra sagittaria* Dickerman). I must apologize to Dr. Dickerman for thus singling him out among others, but I have risked offense to this author in order to cite a recent and specific example of a practice in systematics that is so obviously in error that it cannot rate the approval of anyone interested in correct procedures in taxonomy. That is, two binomials of the Linnaean system (which go so far as to indicate that the larva and adult belong to different genera) are applied to the same animal, which is certainly contrary to approved taxonomic rules and practices.

Historically, of course, the practice stems from the fact that relationships between certain larval forms and the corresponding adult stages were not even suspected, the larvae and the adults being regarded as totally unrelated animals. In the present instance, however, this extenuating circumstance does not prevail. Furthermore, since there is no justification for applying different binary names of the Linnaean system to age classes of the same species (E. T. Schenk and J. H. McMasters, *Procedure in taxonomy*. Stanford Univ. Press, 1935. Art. 26, p. 33), and since the rule of priority is one of the cornerstones of the Linnaean system, it follows that the name first used in designating a species is the correct one to apply to all its developmental stages. Therefore, the correct name of the trematode described by Dickerman must be *Cercaria sagittaria* Dickerman, and not *Proterometra sagittaria* Dickerman, since the former name appears on page 37 of his paper, while that of the latter is on page 39. This is clearly not Dickerman's intention, since he uses *Proterometra sagittaria* in the title of his publication.

The absurdity of giving different Linnaean binary names to developmental stages of the same animal becomes increasingly apparent if extension of the practice to all animals be assumed. Thus, the tadpoles of frogs and toads, different in morphology and in habitat from the adults, might well be given Linnaean names distinct from those designating the adult stage of development. Even the early fetal stages of man, bearing little resemblance to the adult, and certainly in a habitat foreign to fully developed man, might no longer be classed within the genus *Homo*. Such examples could be multiplied indefinitely; in fact, no animal species would be exempt from a *series* of Linnaean binomials applied to various developmental stages, if this practice be extended to its logical conclusion.

The comments of G. G. Simpson (*Bull. Amer. Mus. nat. Hist.*, 1945, **85**, 24) on the use of the Linnaean system are appropriate to the present discussion, for he says that "nomenclature is the grammar and vocabulary of zoology. Neither nomenclature nor grammar is an end in itself, but they are not less important on that account. The comparison can be extended to point out that literate men do not make mistakes in grammar and literate zoologists do not make mistakes in nomenclature. . . ."

A. BYRON LEONARD

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Synthetic Hydrophilic Colloids as Soil Amendments

In Technical Bulletin 189 of Michigan State College, attention is directed to the reduced rate of loss of water by surface evaporation and by transpiration, from greenhouse soils, when such soils are fortified with a suspension of a proprietary methyl cellulose. The results reported were striking. If applicable to Hawaiian soils, in the field, considerable economy in sugar-cane irrigation might be possible.

The important water economies mentioned in this report have not appeared with local soils. When local soils and local soils treated with a suspension of the colloid (the methyl cellulose used was secured from the Dow Chemical Company and is sold under the trade name of "Methocel") are exposed to evaporation, the natural soils lose water at a slightly faster rate, it is true. But the difference is only slightly greater than is required for statistical significance. There seems to be no point in attempting to overcome the great difficulties involved in using this material under field conditions with soils similar to those common in Hawaii.

The results reported in the bulletin cited are more nearly approached when silica sand (testing grade) is used in place of local soil. It would appear that the observed effects were due to a modification of surface and structural characteristics of the soil material and not to the hydrophilic character of the added colloid *per se*.

No significant difference in the rate of evaporation from pure water and from 1-per cent suspensions of methyl cellulose with viscosities of the 25, 400, and 4,000 centipoise grades was noted, when exposed to a constant environment, until the colloid had dried to a horn-like film.

The moisture equivalents of soils and of sands increased progressively with additions of the colloidal suspension. But unit mass of the colloid was much more effective in increasing the water-holding capacities for the sands than the soils.

The permanent wilting percentage of a specific, local natural soil was 23.8 ± 0.04 per cent. When treated with a 1-per cent suspension of the colloid, the permanent wilt-

ing percentage was 23.6 ± 0.04 per cent. Although this difference may be significant, it is so small that it must be ignored if observations on field soils are contemplated.

In spite of its important technical properties, methyl cellulose seems to be of limited use in modifying the water relationships for soils similar to those in Hawaii. For pot tests of soils rich in silica sand or "greenhouse" soils the material may be of considerable value. The fact remains, however, that the high viscosity of dilute suspensions precludes its use in an extensive agriculture, as is suggested in the reference cited.

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Penicillin Action on the Germination of Seeds

In a previous work we have demonstrated that sulfanilamide inhibits the germination of seeds (*J. biol. Chem.*, 1944, **152**, 3, 665–667) and that this drug acts on seeds in the same way as on some germs. It would be reasonable to expect penicillin to act similarly. In order to make evident this possibility, we proceeded as is shown in the following table:

INFLUENCE OF PENICILLIN ON THE GERMINATION OF SEEDS

No.	Penicillin (Oxford Units) per cc.	Germination of seeds	
		24 hours	48 hours
1	1,000	–	–
2	500	–	–
3	100	–	–
4	50	–	–
5	10	–	–
6	5	–	++
7	1	+	+++
8	0.5	++	++++
9	0.1	+++	++++
10	..	++++	++++

Penicillin was diluted to a total volume of 10 cc., and each dilution was placed in small glasses (diameter, 4.5 cm.). In each glass 50 French lettuce seeds (*Lactuca sativa* L. var. *capitata* Roz.) were placed, and the whole was kept at room temperature. The germination of these seeds in water is very rapid, and it is possible to read it after 18 hours from the beginning of the experiment. This observation is made with the eye brought to a level with the surface of the liquid, since the lengthened seeds float and, when they germinate, the radicles grow downward.

Readings taken 24 hours later show a visible difference between the testimony and the sample having received but 0.1 Oxford Unit, thus proving seed sensibility toward penicillin during the germination. After 48 hours seeds ungerminated until then begin to germinate. This may be explained by the fact that penicillin is progressively destroyed at room temperature.

In order to demonstrate that pencillin acts as a phytostatic, as a bacteriostatic does in the case of bacteria, we substituted the solution of penicillin for water after 48 hours in Experiments 1–5, and normal growth of seeds was then observed.

Adding penicillin to seeds not under the effect of the drug and which had begun to germinate was without effect unless a great quantity of penicillin was add (more than 1,000 Oxford Units/cc.).

We have tried to employ a test based on the abo experiments to the quantitative determination of pe cillin, but so far we have had no encouraging resul except for approximative estimation.

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A Substitute for Microfilm Readers

Many laboratories do not yet have convenient acce to microfilm readers. Such literature, however, can b viewed by use of a binocular dissecting scope, using 10 x ocular and a 0.7 x objective. This serves especial well for short references after the whole article has be studied once with a full-sized reader in the colle library. Prolonged periods of reading using the binoc lar would probably prove as difficult as with some the small-sized monocular viewers now on sale.

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An Improved Slide Rule for the Addition of Squares

The writer once constructed a pair of scales similar the C scale of the slide rule described by Dr. Morr (*Science*, 1946, **103**, 113) and has often used them in course on the art of computing, as an aid in teaching t concept of a functional scale, preparatory to the tre ment of the logarithmic slide rule and of nomograp in general. On reading Dr. Morrell's note it was con quently evident that the number of operations necess to solve the given equation, $d = (x^2 + y^2 + z^2)^{\frac{1}{2}}$, can markedly reduced by using such a pair of scales.

In the procedure indicated by Dr. Morrell (p. 11 only the B scale and the cursor are actually used; the scale is referred to descriptively, and the others not at The operations involve three settings of the cursor, t settings and a third motion of the slider, and the fi reading. If we have a pair of scales, the zero of slider can be first set at the value of x on the fixed sc and the cursor at y on the slider, which will be $(x^2 + y^2)^{\frac{1}{2}}$ of the fixed scale. Then, bringing the zero the slider to the hair line of the cursor, we have the va of d on the fixed scale opposite that of z on the slid This involves two settings of the slider and a final rea ing, as before, but the third motion of the slider is eli nated and there is but a single setting of the curs unless a second setting be used as an aid to interpolati of the final reading.

As Dr. Morrell's A and D scales are identical exce for the decimal point, both are not really necessary, a one of them could be replaced by a fixed duplicate of o of his movable scales. Were the writer to need an instr ment for the problem described, the disposition wou probably be: A and B like Dr. Morrell's C; C and D li his B; and a fifth scale, of equal parts, replacing his and D, on the slider between B and C.

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Book Reviews

Tihuanacu: the cradle of American man. Arthur Posnansky. New York: J. J. Augustin, 1945. Vol. I: Pp. viii + 158; Vol. II: Pp. viii + 246. (Illustrated; bound in one volume; text in English and Spanish.) $30.00.

In this large, expensive, and beautiful work, which includes two of three projected volumes, Prof. Posnansky, Bolivia's leading archaeologist, summarizes a lifetime of research in the rich archaeological remains of the Bolivian altiplano. The work contains many excellent descriptions of the sites and monuments, but it is mainly of interest in illustrating how a scientist, working alone and without reference to his colleagues, arrives at results wholly at variance with theirs. Scientists may, of course, make outstanding contributions by courageously defying tradition; but they can rarely afford to ignore established methodology, accumulated data, and other gains of the past.

Ignoring his colleagues, except to hurl an occasion invective at them, Prof. Posnansky erects a theoretical structure that is entirely his own. It is of interest to compare it with that of his fellow archaeologists.

Tihuanacu (usually spelled Tiahuanaco) is an archaeological site on the Bolivian altiplano famous for its monolithic gateways, carved stone blocks, idols, and art style. Archaeologists have found the art style widely spread in the Andes, and, by means of stratigraphy and other standard archaeological methods, they have dated this phase of culture at the close of the first millennium A.D. It is generally regarded as a comparatively late manifestation of an advanced, prehistoric Andean civilization which developed through several distinctive periods over some 2,000 years.

Prof. Posnansky, like so many local archaeologists who do not build on the work of their colleagues, sees his Bolivian Tihuanacu remains as the product of autochthonous development and as the source of all American civilization. He postulates five local periods. During the first, the superior Kholla, who seem to be identified with the modern Aymara, subjugated the inferior, cave-dwelling, Arawak-speaking natives. The racist dogma and the identification of the language of these early people are favorite themes of the author. After a glacial period, which is correlated with that of other parts of the world, Periods 2 and 3 brought the flowering of Tihuanacu, some 10,000 to 15,000 years ago. Tihuanacu's decline was followed by Period 4, when the polygonal stone work at Cuzo was made. (This stone work is now identified as Inca.) In characterizing Period 5 by the "monumental adobe" structures, which are found mainly on the coast, the author seems to disregard the fact that his colleagues find that such structures date from all periods of prehistoric Peru. Period 6 is Inca—that is, of the historic, Quechua-speaking peoples.

Failing to use established ceramic sequences, Posnansky based his reconstruction on a series of assumptions which have not been generally accepted: that the so-called Arawak cave dwellers are oldest because their skulls are fossilized; that the Tihuanacu culture flourished during Periods 2 and 3 because the altiplano was then nearer sea level and had a more benign climate; that this culture declined, because of uplifts, vulcanism, increased cold, recession of Lake Titicaca, and a consequent decrease of population. Whereas other archaeologists prefer a relative chronology for their periods and hazard an absolute chronology only by general comparisons with such areas as the Maya, who erected dated monuments, Prof. Posnansky bases his on assumed glacial chronology, on an assumed uplift of the Andes and changes in the level of Lake Titicaca, and on a variety of astronomic calculations which he infers from the arrangement of temples, monoliths, and other structures.

That Tihuanacu was the cradle of American civilization Posnansky deduces from a series of design elements, or "signs," such as "staircase" (stepped element), "star," "condor," "puma," and the like, which he identifies at Tihuanacu and assumes to have been spread by migrating Khollas to wherever such elements are found throughout the Americas, even as far away as the Hopi of Arizona. This postulated origin and spread of the Tihuanacu civilization is accomplished with a complete disregard of the tremendous amount of work done by competent archaeologists throughout the Americas.

Leaving aside its interpretative features, Prof. Posnansky's volumes are a magnificent factual contribution, containing the most important corpus of data yet available on the monolithic doorways, steps, walls, canals, idols, and other features of this interesting and important culture.

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Bibliographia araneorum: analyse méthodique de toute la littérature araneologique jusqu'en 1939. **(Tome I.) Pierre Bonnet. Toulouse: Frères Douladoure, 1945. Pp. xvii + 832. 3,500 fr.**

This is an attempt to make a complete survey of all scientific literature dealing with one group of animals, the spiders, and serves as an example of the type of comprehensive bibliography that all fields could use if such were available. Prof. Bonnet has assembled over 8,000 titles, arranged alphabetically by authors, and then has made a thorough analysis and grouping of these papers by every sort of heading that a student might need—general heads such as usefulness to humans, technical methods, and phylogenetic relations; anatomy and physiology, such as coloration, glands, and heart movements; ethology, including longevity, catalepsy, courting habits, etc.; geographic distribution by states, departments, counties, islands, etc.; and paleontology.

Included is a brief summary of the outstanding work done in arachnology from the time of Aristotle to the

present, and a biographic account of 124 araneologists from Linnaeus to date, with portraits of 106 of these. There is also a discussion of typographical and nomenclatural rules employed in this volume, and indexes of authors and subjects.

Prof. Bonnet did his own editing and is preparing a supplement in which any corrections and additions that come to his attention will be made. A brief account in the Postface of the struggles he had with governmental red tape and paper shortages will constitute a bond of sympathy with any harassed editor in this country.

The second and third volumes, yet to be published, will arrange the systematics of all spiders known to the author and a synonymy of some 200,000 names. This work will, of course, be an invaluable reference tool to any zoologist and naturalist, as well as a model and a challenge to students of fields other than arachnology.

RELIS B. BROWN

University of Mississippi

Howell's textbook of physiology. **(15th ed.) John F. Fulton. (Ed.) Philadelphia: W. B. Saunders, 1946. Pp. xxxv + 1304. (Illustrated.) $8.00.**

Only a few resemblances between this and the earlier editions remain. Among them are the retention of the original author's name, now moved up into the title, and a barely recognizable similarity to the earlier format. Under the able editorship of John F. Fulton the book has been completely revised and rewritten and stands today as a fitting memorial to one of America's great medical educators. Twenty-four physiologists have contributed to the work, 15 of them from Yale.

Of its 1247 pages of text, 545 are devoted to nervous and sensory physiology. However, those who wish an authoritative account of modern nervous physiology will be satisfied with the large proportion of space allotted to this subject, for it would be difficult indeed to find a more thorough treatment of this complex field. It would be futile to try to summarize even the full body of material presented; suffice it to say that it is all there. The three major contributors to this section of the book, J. F. Fulton, D. P. C. Lloyd, and T. C. Ruch, deserve only the highest praise for the manner in which they have synthesized and summarized those advances in nervous, muscular, and sensory physiology resulting from the increased application of the methods of oscillography to these fields.

A section on blood and circulation comprises 309 pages and is as admirably done and as up to date in scope as the preceding one. It is a composite effort on the part of D. J. Hitchcock, D. H. Barron, H. Lamport, and J. F. Fulton and includes a chapter on the pulse by W. F. Hamilton, who is certainly well equipped to handle this subject. Areas in which recent advances in circulatory physiology have been made, such as the fractionation of plasma proteins, electrocardiography, and ballistocardiography, and the coronary and cerebral circulation, are well covered.

Since 854 of the 1247 pages of text have been devoted to nervous, sensory, and circulatory physiology, not mu space is left for the rest. Consequently, the treatme accorded such important fields as respiration, kidn function and water balance, digestion, etc. is less co prehensive than that in the earlier sections of the boo However, although kidney physiology, including a di cussion of water balance, takes up only 50 pages, in this short space R. W. Clarke has managed to compre all the essential facts, including an able presentation Smith's recent work on tubular excretory (absorptiv mass. Such a compact presentation will satisfy the me ical students who have long suffered in their textboo lengthy treatments of certain physiological subjects m suitable to monographs for the advanced specialists.

Again, in the section on respiration, we are grea indebted to R. F. Pitts for an excellent and succinct su mary of the recent work in this field, including a di cussion of the newer concepts of the respiratory cen to which Pitts himself has added so much. It is int esting to note that the section on digestive physiol was written by G. R. Cowgill, who is also responsi for the same section in another well-known physiol text. Metabolism and nutrition are well done by J. Brobeck and include much new material on temperat regulation, vitamin action, and intermediary metaboli The section on reproductive physiology, edited by W. Gardner, maintains the same high standards of the oth

Clinical applications of physiology are not discus except as they serve to clarify the strictly physiolog material and to enliven the text. Recent trends in ph ology are nicely balanced in their presentation and sh orient the student as to the direction in which this sci is moving without confusing him unduly with conflict opinions. At the end of each section is a short biblio phy which gives any individual who wishes to read f ther in the subject a good start in his quest for original literature. There is happily included as an troductory chapter an historical account of the deve ment of American physiology. An excellent index gre increases the usefulness of the book.

A section devoted to the endocrines is lacking. T was obviously deliberate policy, the material usually corporated in such a section being scattered through book under those parts dealing with carbohydrate m tabolism, electrolyte and water balance, etc. This p cedure has much to recommend it since it diverts att tion from the endocrine glands as anatomical entities their function as integrators of bodily activity. Bu this particular instance the interrelationships which e between the endocrines themselves and which play an portant role in the regulation of bodily function are c pletely neglected. For instance, it would be hard in for the student to discover that thyroid activity is trolled by a reciprocal relationship between the thy and pituitary gland. Further, this reviewer would interested to know if anyone can find mention of parathyroid gland. He could not.

DIETRICH C. SI

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